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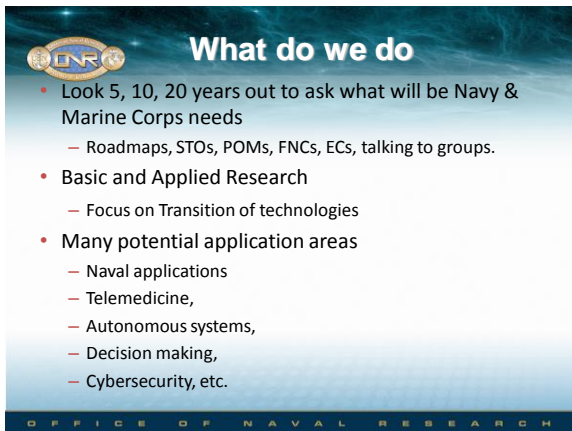
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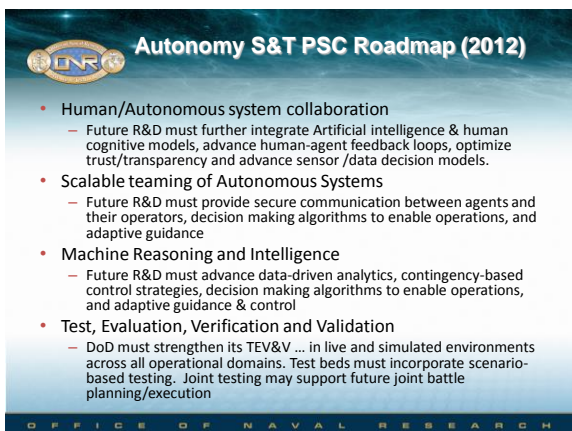
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## Goals for Human Impact

- Assumption that human will always be 'in-the-loop'
- Support the human roles
  - Doing more, faster with fewer personnel
- Design of autonomous systems need to consider human role first
  - Not just how the task is done, but why do it that way
  - Reduce the cognitive load on the operators

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## Management of Hybrid Heterogeneous Autonomous Systems

- How can two fallible collections of autonomous systems work together?
  - Humans and systems WILL fail
- Autonomy to increase operator control and situation awareness over collective, heterogeneous systems
  - Includes interface development, but not focus
  - One to Many → Many to many? When? How?
  - Increase coordination/reduce error
- Autonomy to help optimally allocate the human operators' limited cognitive resources to mission critical tasks
  - Need metrics of robust task effectiveness
    - How do we know when we've made an improvement?
  - Maintain awareness of higher order goals
    - Shift turnover



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## Gap: Understanding the task

- Mission, interface, operator model coherence
  - CTA, FRA, FA necessary but not sufficient:
    - Must understand why task is performed that way
    - What happens to the process when you insert autonomy?
    - Which rules still apply? Why?
  - Misplaced faith in realistic displays (Naïve Realism, Smallman & St. John, 2005)
    - e.g., simulated toggle switches in simulators
    - Selection of data sources for fusion algorithms without analysis of task needs.
    - Faulty design assumptions wrt how the task can/should be performed

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## Gap: System Brittleness & Resilience

- Surprise is guaranteed
  - People fail & Machines fail
  - Failure in the face of surprise can yield catastrophic event
  - Changing technologies changes the source and form of risk
- Performance Shaping Factors
  - From HRA, factors assumed/known to influence the probability of human error
  - How much? How do they interact?
  - Current approach often 'Blame, shame, retrain'
  - Just remove the human from the system...

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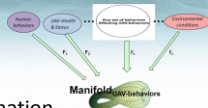


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## Gap: Cooperation and behaviors

- Operator goals change
  - System needs to adapt
  - System should provide information to indicate when goal should change
- Off-normal occurrences
  - Operators must focus on details
  - Many to one breaks down
  - When to switch? How to cue?

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## Gaps: Too much data

- Adoption of autonomous systems by DoD
  - Varying levels of autonomy
    - Variations in systems
  - Capabilities greater (and lesser) than operators can handle
  - Budgets for personnel are declining
    - Just-in-time staff replacement
- Sensors evolve, outstrip the human ability to process the data (D2D)
  - 'Data' is not 'information' until it has meaning (processing, context)
- The human is the source of all decisions and integrator of all data
  - Connectivity of distributed information

*Everybody gets so much information all day long that they lose their common sense. —Gertrude Stein*

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## Gap: Variations in Solutions

- Different algorithms can yield the same outcome (e.g., anomaly detection or navigation)
  - But mission, task, context and operator goals determine which instantiation satisfies/optimizes the task
  - How does the system 'know' which to use? Why should the operator decide this?
    - Operator overload if human has to select
    - Designers choose different instantiations



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## Research needs

- **Performance metrics**
  - Operator as well as kinematics/mechanical
  - Mission 'satisfaction'
  - System of systems; multiple scales
- **Allocating human and system resources**
  - Predicting and preventing errors
  - Building mental models to assist diagnosis
  - Situation awareness to anomalies
  - Ranges of teams and relationships
- **Accommodating changing goals and events**
  - Adjusting models to new information
  - Making the impact of new information apparent




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## Current research

- Recognizing interactions and gestures
- Developing mental models for maintenance
- Visual Analytics and Automation Schema
- Interfaces for Future Unmanned Systems
- Supervisory Control UAS
- Performance Metrics for Autonomous Systems
- Detection and Alerting Anomalous Behaviors
- Focusing, Sustaining, and Switching Attention
- Predicting & Preventing Errors in Procedural Tasks
- Satisficing for Autonomous Decision Making
- Visualization of Fused, Complex Data sets

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